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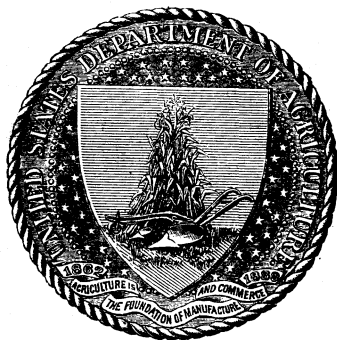
FARMERS' BULLETIN No. 99.

THREE INSECT ENEMIES OF SHADE TREES.

BY

L. O. HOWARD,
ENTOMOLOGIST.

[Reprinted, with some annotations by the author, from the Yearbook
of the Department of Agriculture for 1895.]



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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF ENTOMOLOGY,

Washington, D. C., May 26, 1899.

SIR: I have the honor to transmit herewith a copy of an article contributed by me to the Yearbook for 1895, entitled "The shade-tree insect problem in the Eastern United States." I have found the reprints of this article of great use in correspondence, and as the edition is exhausted, I recommend that it be republished, under the title *Three Insect Enemies of Shade Trees*, as a Farmers' Bulletin. I have in preparation a more extended bulletin on the subject of shade-tree insects, but in the interval which will elapse before it is completed the Farmers' Bulletin reprint of the Yearbook article will be of service.

Respectfully,

L. O. HOWARD,
Entomologist.

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

	Page.
The imported elm leaf-beetle	7
Original home and present distribution	7
Food plants	8
Life history	8
Remedies	10
The white-marked tussock moth	12
Original home and present distribution	12
Food plants	12
Life history and habits	12
Remedies	17
The fall webworm	20
Remedies	20
The relative immunity from insects of different varieties of shade trees	21
General work against shade-tree insects in cities and towns	25

ILLUSTRATIONS.

	Page.
• FIG. 1.—Bagworm (<i>Thyridopteryx ephemeraeformis</i>)	5
2.—Bagworm; successive stages of growth	6
3.—The imported elm leaf-beetle (<i>Galerucella luteola</i>)	9
4.—White-marked tussock moth (<i>Orgyia leucostigma</i>)	13
5.—Tussock-moth caterpillar, first three stages	14
6.—Tussock-moth caterpillar, last stages	15
7.—Silver maple leaves eaten by larvæ of white-marked tussock moth in successive stages	18
8.—Ichneumonid parasites of tussock-moth caterpillar	19
9.—Fall webworm (<i>Hyphantria cunea</i>), moths and cocoons	24
10.—Fall webworm, forms of larva and pupa	26
11.—Fall webworm, larva and web	27

THREE INSECT ENEMIES OF SHADE TREES.

The space at command will not admit of a full treatment of the problem outlined in the [original] title of this article, and the writer has therefore brought together at this time some account of three species which are perhaps the most destructive among shade-tree insects, or which, at all events, have attracted the greatest attention during the past season. To this he has added a brief consideration of the relative immunity of shade trees from insect attack, and some remarks on the subject of general work against shade-tree insects in cities and towns.

One of the most striking features of the summer of 1895 has been the great abundance in many Eastern cities of several species of insects

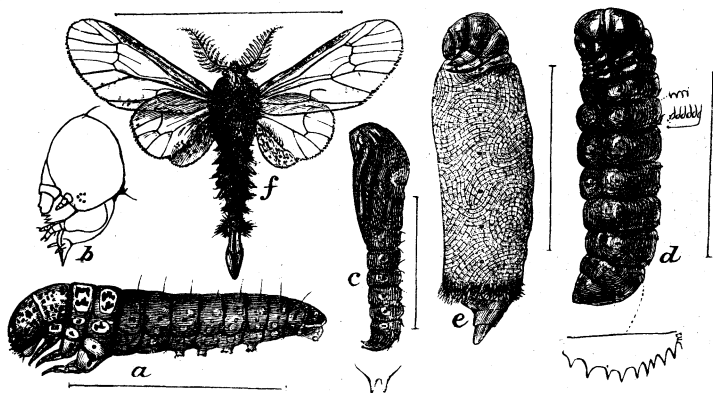


FIG. 1.—Bagworm (*Thyridopteryx ephemeraeformis*). a, larva; b, head of same; c, male pupa; d, female pupa; e, adult female; f, adult male—all enlarged (original).

which attack shade trees. In almost every low-lying town from Charlotte, N. C., north to Albany, N. Y., the elm leaf-beetle has defoliated the English elms and, in many cases, the American elms. In certain directions this insect has also extended its northern range, notably up the Connecticut River Valley. The authorities in a number of Eastern cities have taken the alarm, and active remedial work will be instituted during the coming season. In cities south of New York the bagworm has been gradually increasing for a number of years until it has become a serious enemy to shade and ornamental trees for almost the first time since 1879 or 1880 (figs. 1 and 2). The white-marked tussock moth, the caterpillar of which has been for many years the most serious of the shade-tree pests in Philadelphia, New York, Brooklyn, and Boston, in 1895, for the first time within the recollection of the writer,

appeared in such numbers as to become of great importance in more southern cities, as Baltimore and Washington. The fall webworm (figs. 9, 10, and 11) was more abundant in Washington and the surrounding country than it has been since the summer of 1886.

These four insects are the principal shade-tree defoliators in the Eastern States, if we except the imported gypsy moth, which is at present fortunately confined to the immediate vicinity of Boston, and is being cared for by a thoroughly capable State commission. While the summer of 1895 may with justice be called an exceptional one as regards the great increase of numbers, yet these insects are always present and do a certain amount of damage each season, and, when an exceptional season comes, as it did in 1895, city authorities seldom find

themselves prepared to engage in an intelligent and comprehensive fight.

In cities farther west other leaf-feeders take the place of those just mentioned. The principal ones are, perhaps, the oak Edema, the cottonwood leaf beetle, and the green-striped maple worm.

Several scale insects or bark lice are occasionally serious enemies to shade trees. Maples suffer especially from their attacks. The cottony

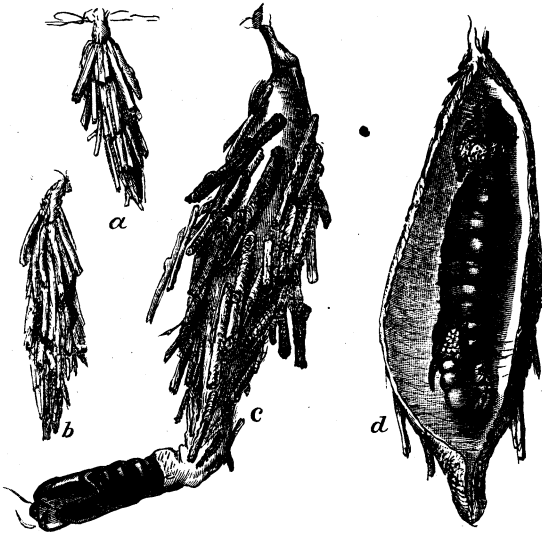


FIG. 2.—Bagworm at (a, b, c) successive stages of growth. c, male bag; d, female bag—natural size (original).

maple scale is found everywhere on all varieties of maple, and occasionally in excessive abundance. The cottony maple leaf scale, a species imported from Europe, is rapidly gaining in importance, and in several New England towns it has, during the past season, seriously reduced the vitality of many trees. The so-called "gloomy scale" has long been on the increase in Washington, D. C., and every year it kills large branches and even entire trees of the silver maples, which are so extensively grown along the streets of that city.

Certain borers are also occasionally destructive to many shade trees, and, in fact, in the northern tier of States these are the most important of the shade-tree enemies, the principal leaf feeders being either absent or becoming single brooded. Where absent their places are taken by less destructive species.

In fact, it is safe to say that shade trees suffer especially from insect attack throughout the region of country which is contained in the Upper Austral life zone.¹

Concerning the borers, it may be briefly said that these insects rarely attack vigorous and healthy trees, but should a shade tree lose its health through the attacks of scale insects, through rapid defoliation by leaf feeders, or through a leaky gas main or sewer pipe, different species of borers will at once attack and destroy it. There is one particular exception to this rule, and that is the European leopard moth, a most destructive species, which is at present of very limited range and confined to the immediate vicinity of New York City. No certain information is at hand which indicates that it has spread for more than 50 miles from the center of introduction. This insect attacks healthy trees, boring into the trunks of the younger ones and into the branches and smaller limbs of many shade and fruit trees. It is an extremely difficult species to fight, and it is fortunate that its spread is not more rapid.

THE IMPORTED ELM LEAF-BEETLE.

(*Galerucella luteola* Müll.)

Original home and present distribution.—The imported elm leaf-beetle (fig. 3) is a native of southern Europe and the Mediterranean islands. It is abundant and destructive in the southern parts of France and Germany, and in Italy and Austria. This beetle is found, though rarely, in England, Sweden, and north Germany, and gradually becomes less numerous and destructive toward the north. In middle Germany it is common, though not especially destructive. As early as 1837 it was imported into the United States at Baltimore, and is now found as far south as Charlotte, N. C. From this point it ranges northward in the Atlantic cities as far as Providence, R. I. Inland it has not passed the barrier of the Appalachian chain of mountains, and is practically confined to the Upper Austral region, as indicated in the map on page 210 of the Yearbook for 1894. Thus, up the Hudson River it has spread to Albany, N. Y., but on either side of the river, as the land rises into the foothills, it has stopped. In the same way it has more recently spread up the Connecticut River Valley to a point north of the New Hampshire State line, and also, to a less extent, up the Housatonic Valley. From our present knowledge it seems likely that its future spread as an especially destructive species will be limited by the northern border of the Upper Austral region, and that (as may happen at any time) should it once be carried by railway train across the southern extension of the Transition life zone, caused by the Alleghany and Blue Ridge mountains, it will spread unchecked

¹ Briefly defined by Dr. Merriam in his summary article on "The geographic distribution of animals and plants in North America," in the Yearbook of this Department for 1894, page 203.

through Ohio, Indiana, Kentucky, Tennessee, and other Western States.¹

Food plants.—No food plants other than elms are known. The common English elm (*Ulmus campestris*) is its favorite food, and the gardener's variety, the so-called Camperdown, or weeping elm, is attacked with equal avidity. The American, or white, elm (*U. americana*) ranks next among the favored species, with *U. montana*, *U. suberosa*, *U. flava*, *U. racemosa*, and *U. alata* in about the order named. No variety seems absolutely exempt. In the presence of *U. campestris* other elms are seldom seriously injured. Where *campestris* is absent, or where a single tree of *campestris* is surrounded by many American elms, the latter become seriously attacked.²

Life history and habits.—The elm leaf-beetle passes the winter in the adult, or beetle, condition in cracks in fences or telegraph poles, under the loose bark of trees, inside window blinds in unoccupied houses, in barns, and, in fact, wherever it can secure shelter. As soon as the buds of the trees begin to swell in the spring, the beetles issue from their winter quarters and mate, and as soon as the buds burst they begin to feed upon the leaflets.

This feeding is continued by the beetles until the leaves are fairly well grown, and during the latter part of this feeding period the females are engaged in laying their eggs. The eggs (fig. 3, *c*) are placed on the lower sides of the leaves, in vertical clusters of 5 to 20 or more, arranged in two or three irregular rows. They are elongate oval in shape, tapering to a rather obtuse point, orange yellow in color, and the surface is covered with beautiful hexagonal reticulations. These reticulations, however, can be seen only with a high magnifying power.

The egg state lasts about a week. The larvæ (fig. 3, *d*) as soon as hatched feed on the under surface of the leaf, gradually skeletonizing it. They reach full growth in from fifteen to twenty days, and then either crawl down the trunk of the tree to the surface of the ground or drop from the extremities of overhanging branches. At the surface of the ground they transform to naked, light orange-colored pupæ (fig. 3, *g*), a little over a quarter of an inch in length, and in this stage they remain for from six to ten days, at the expiration of that time transforming to beetles. The pupæ will frequently be found collected in masses at the surface of the ground in this way. On very large trees with shaggy bark many larvæ will transform to pupæ under the bark scales, or on trees of the largest size they may descend the main

¹ Since this was written the writer has learned that this passage of the Blue Ridge barrier has actually taken place during the past season. Mr. A. D. Hopkins, of the West Virginia Agricultural Experiment Station, has found that this insect has established itself at Elmgrove, in Ohio County, and at Wellsburg, in Brooke County, W. Va.

² The beetles rarely oviposit upon *Zelcova carpiniaefolia* and *Z. acuminata* on the Department grounds at Washington.

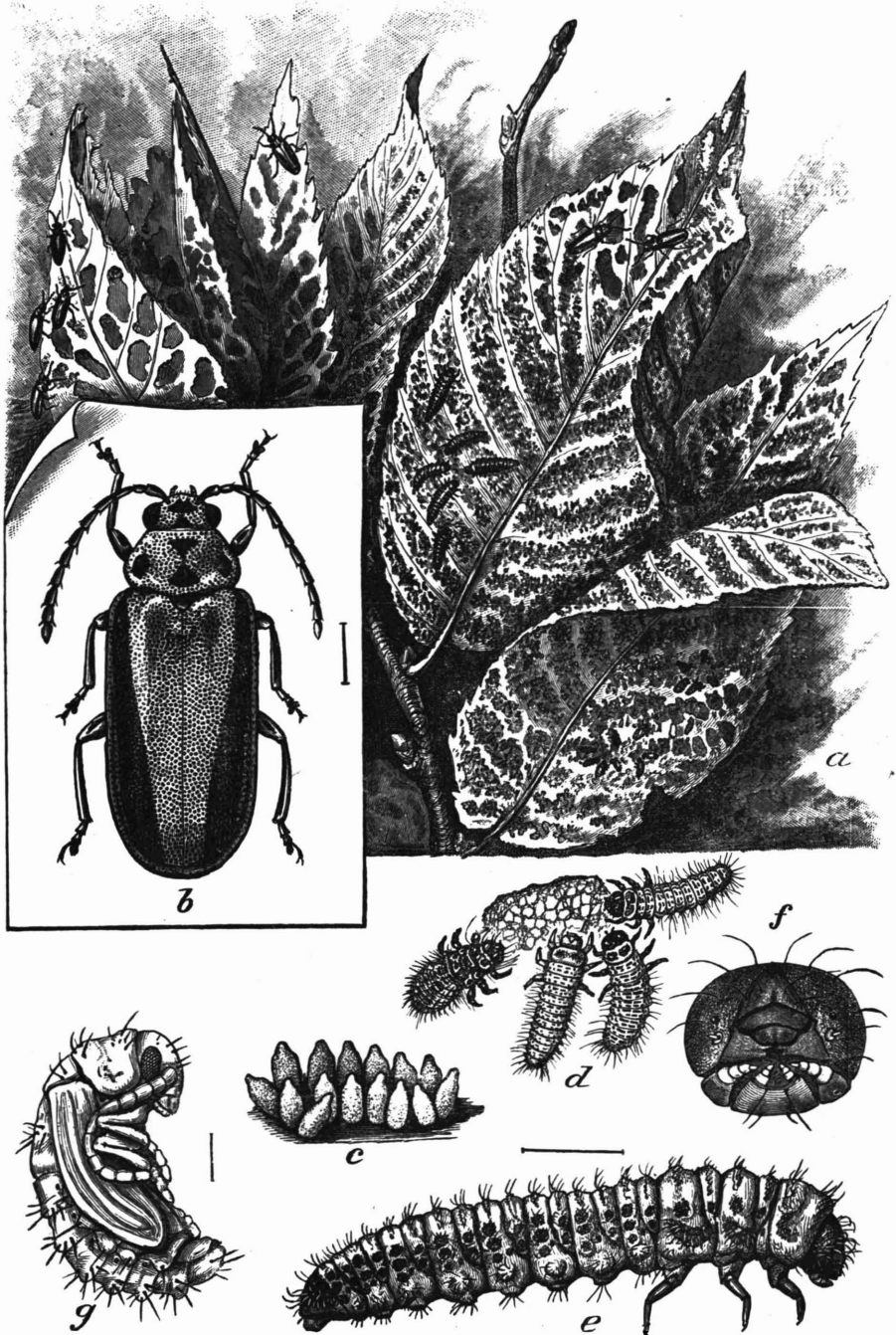


FIG. 3.—The imported elm leaf beetle (*Galerucella luteola*). a, foliage of European elm showing method of work of beetle and larva—natural size; b, adult beetle; c, egg mass; d, young larvæ; e, full-grown larva; g, pupa—all greatly enlarged; f, mouth parts of full-grown larva—still more enlarged (original).

branches to the crotch and transform unprotected in the hollow of the crotch.

The larva is elongate, reaching when full grown (fig. 3, *e*) half an inch in length. When first hatched it is nearly black; as it increases in size it becomes, with each shedding of the skin, more distinctly marked with yellow, and when mature the yellow predominates, occurring as a broad dorsal stripe and two lateral stripes.

The difference between the early work of the beetles and the later work of the larvæ is recognized at a glance. The beetles eat entirely through the leaves and make complete, irregular holes, while the larvæ simply eat the parenchyma from below, skeletonizing the leaf.

The time occupied in egg laying is long, and it thus happens that at the time when full-grown larvæ, and even pupæ, are to be found there are also upon the leaves freshly laid eggs.

In Washington there are invariably two generations annually, the beetles developed from the eggs laid by the overwintered beetles themselves laying their eggs in July. The adults issuing from these eggs make their appearance in August. Farther north, at New Brunswick, N. J., and in the Connecticut cities, it may be said that there is normally a complete first generation and an incomplete second generation.

The proper food of the larvæ is the rather young and tender leaves. If the work of the first generation has not been complete, and the trees have not been so nearly defoliated as to necessitate the sending out of fresh leaves, or if a period of drought ensues after defoliation and prevents the putting out of a second crop of leaves, the beetles of the first generation do not lay eggs, but after flying about for a time seek winter quarters. This may occur as early as the middle of July. Where, however, defoliation has been complete and has been followed by a period of sufficient moisture to enable a tree to put out a fresh crop of leaves, the beetles of the first generation will lay their eggs and a second generation of larvæ will develop upon this comparatively tender foliage. Where similar conditions prevail in Washington and its vicinity, a third generation of larvæ may develop, though small in numbers, but the writer is convinced that even in Washington late-developing beetles of the first generation may hibernate.

Remedies.—The only thoroughly satisfactory safeguard against this insect consists in spraying the trees with an arsenical solution. The only other remedy which is worthy of mention is the destruction of the larvæ at the surface of the ground before or after they transform to pupæ. The latter remedy, however, is not complete, and even where it is carefully carried out for every tree in a city it will do no more than reduce the numbers of the insects by perhaps two-thirds.

Ten years ago a proposal to spray the enormous elms which are to be found in many Northern towns would have been received with ridicule, but of recent years the practicability of the plan has so frequently been demonstrated that there is no hesitancy in commending

it to more general city use. Probably the largest elm tree in America, the Dexter elm at Medford, Mass., has been successfully and economically sprayed by the Gypsy Moth Commission. It is necessary to have especial apparatus constructed, and it is equally necessary to have the work done by men who are accustomed to it or at least are good climbers. The first successful work of this kind was probably that done by Prof. John B. Smith, on the campus of Rutgers College. He had a strong barrel pump, and carried the nozzle at the end of a long rubber tube, with a bamboo extension pole, up into the center of the trees by climbing a ladder to the main crotch. From this point the spray was thrown in all directions, and the tree was thoroughly coated with the mixture in a minimum of time.

The Gypsy Moth Commission, in their earlier spraying work, sent their large tank carts through the streets, stopping at each tree and sending one or more men with hose and extension poles into it, thus covering hundreds of large trees in a single day. If steam sprayers are used (and the town or city fire engines can be and have been used to excellent advantage in this way), the necessity for climbing the trees may be largely avoided. By means of multiple-discharge hose both sides of a tree, or even of two trees, may be sprayed at once, and the extent of territory that may be covered in a day is surprising. The elm trees in a small park may be treated economically and without much difficulty by two or three men with a handcart tank. This method has been adopted on the large grounds of the Department of Agriculture with absolute success.

The writer's experience at Washington leads to the conclusion that it is important to spray trees once just after the buds have burst. This spraying is directed against the overwintered beetles. If a large proportion of these beetles can be destroyed by poisoning the leaves which they eat, not only will a great deal of leaf perforation by the beetles themselves be prevented, but the number of eggs laid will be very greatly lessened. A second spraying should be conducted two weeks later. This is directed against the larvæ, the majority of which will perhaps have hatched by that time or soon after. A third spraying, and even a fourth, or under exceptional circumstances a fifth, may be required if it is considered necessary to keep the trees fresh and green, and particularly if the earlier sprayings have been followed by rains, as is apt to be the case in the earlier part of the season. In Bridgeport, Conn., where only a part of the trees are sprayed and these by private enterprise, an even greater number of operations have been found desirable. Three thorough sprayings of all the trees in a given precinct will probably be as much as will be required, especially if this be done year after year and some pains be taken to destroy such of the larvæ as may successfully develop and descend for transformation. Even two sprayings, covering all the elms of a city or town, will be well worth the expense.

The substance to be used in these spraying operations may be Paris green, London purple, or arsenate of lead. The directions for the use of these substances have been so often repeated, that it is not worth while to mention them here.

The other remedy—the destruction of the descending larvæ and the quiescent pupæ—is, as above stated, and must always be, incomplete. The standard kerosene emulsion, diluted one part to five parts of water, will destroy the insects in either of these stages. This has been successfully used in several New England towns the past season, particularly in New Haven. It must be applied to the base of the trunk and under the entire limb spread of the tree. The rough bark must be removed to a slight extent (the writer does not advocate severe scraping), leaving as few crevices as possible which may harbor the pupating insects. If a tree is very large, it will pay occasionally to climb into the main crotch and destroy such individuals as may have collected at that point. Experience leads us to the estimate that on large trees not more than one-half to two-thirds of the larvæ reach the base of the trunk and transform at that point. The extent to which larvæ drop from overhanging branches has been questioned, and it is sometimes a difficult matter to decide. The city forester of Springfield, Mass., however, called our attention to a peculiar and eminently satisfactory case where the drooping branches of a large elm extended completely over a house on the other side of which there were no elm trees. On the far side of the house, beneath the tips of the overhanging branches, the larvæ and pupæ were collected in large numbers in the summer of 1895.

THE WHITE-MARKED TUSSOCK MOTH.

(*Orgyia leucostigma* Smith and Abbot.)

Original home and present distribution.—This insect is a native of North America. It ranges from Jacksonville, Fla., to Nova Scotia, on the eastern coast, and extends west certainly as far as Keokuk, Iowa, and probably farther, although the records at command include no actual captures beyond this point.¹ It does not occur in California, so far as learned.

Food plants.—It attacks almost every variety of shade, fruit, and ornamental trees, with the exception of the conifers. In the city of Washington it seems to select by preference the poplars, soft maples, the elms, alders, and birches, as well as the willows. It is also found here on apple, pear, cherry, plum, peach, other varieties of maple, locust, box elder, ash, catalpa, rose, horse-chestnut, persimmon, sycamore, mulberry, and a number of other trees.

Life history and habits.—This insect passes the winter in the egg state. The overwintering eggs are laid by the female moth in the latter

¹ Prof. L. Bruner has since reported this species from Omaha and Lincoln, Nebr.

part of September, in a glistening white, frothy-looking mass attached to the outside of the cocoon. They are seen at a glance, owing to their pure white color, and remain conspicuous upon the trees until spring. The caterpillars hatch in Washington in April and May. They are represented at different stages of growth in figs. 4, 5, and 6, and in view of the care with which these figures have been drawn detailed descriptions will be unnecessary. They cast the skin five times, exhibiting a different character after each molt, as indicated in the

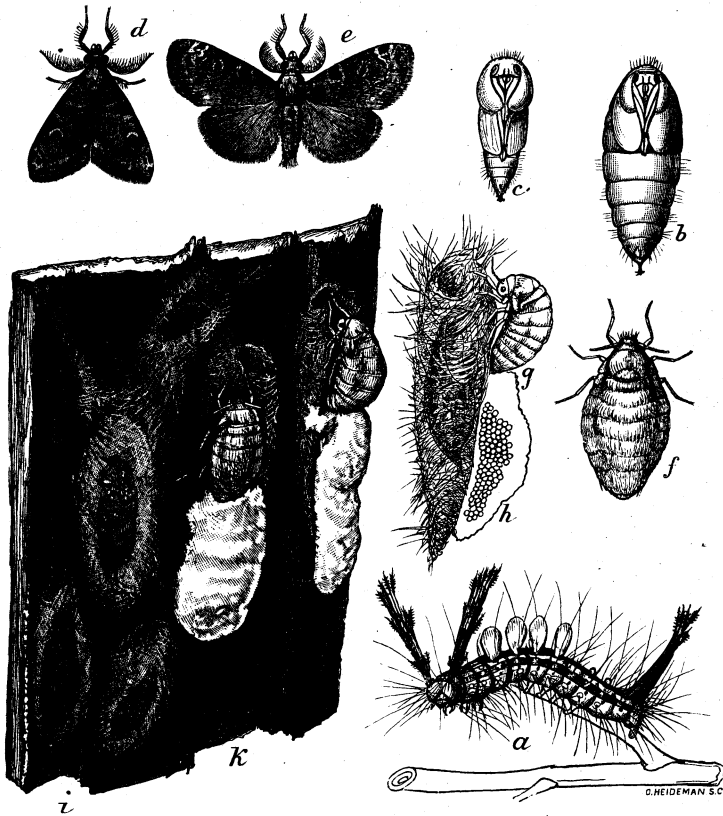


FIG. 4.—*Orgyia leucostigma*. a, larva; b, female pupa; c, male pupa; d, e, male moth; f, female moth; g, same ovipositing; h, egg mass; i, male cocoons; k, female cocoons, with moths carrying eggs—all slightly enlarged (original).

figures. The newly hatched young feed on the under surface of the leaf, eating off the parenchyma and producing a skeletonized appearance. After the first molt the skeletonizing continues, but a few holes are eaten completely through the leaf; after the second molt many holes are eaten through between the main ribs, and after the third molt the leaf is devoured, except for the midrib and its principal branches. After the fourth molt the caterpillars begin to eat from the edge of the leaf and devour everything except the principal veins.

Similar work is done in the last stage upon the full-grown and tough leaves (see fig. 7).

A most peculiar kind of damage by the caterpillars of this species has been observed by Dr. Lintner in Albany, N. Y. There, in the summer of 1883, he found that the tips of many twigs were girdled by the caterpillars, which had entirely removed the bark for a tenth of an inch. Such twigs broke off and fell to the ground, with their leaves. This damage was so common in 1883 that the sidewalks of the streets and public parks wherever the American elm was growing were sprinkled with the newly fallen leaves. Dr. Lintner was of the opinion that a cold spring and the sudden advent of warm weather caused an unusually vigorous growth of the terminal twigs, and that the young tips were therefore unusually tender. They thus proved

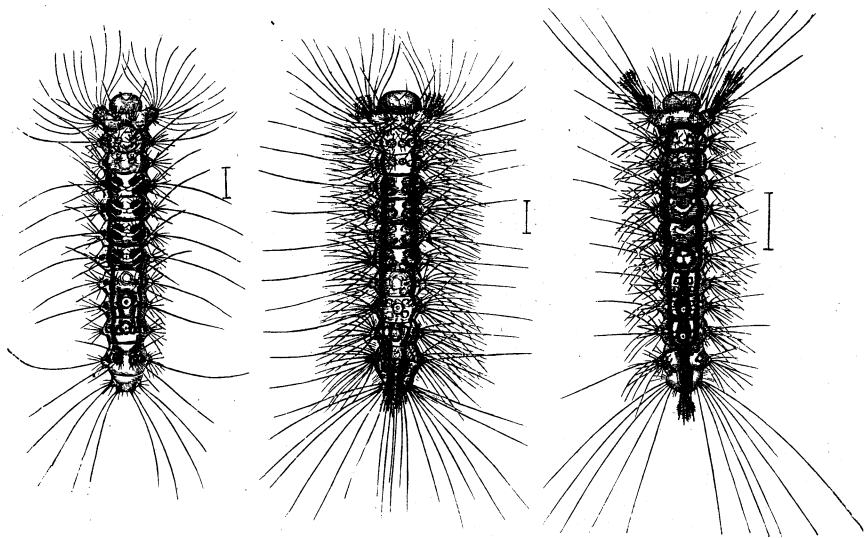


FIG. 5.—Tussock-moth caterpillar. First, second, and third stages—enlarged (original).

appetizing to the tussock-moth caterpillars, which developed a new habit for the occasion. This peculiar damage was repeated in 1895, but to a less extent. No other observer in any part of the country has ever reported similar damage.

The young caterpillars drop down, suspended by silken threads, at even a slight jarring of the tree, and frequently spin down without such disturbance, and are blown to a considerable distance by the wind. When nearly full grown they are great travelers, crawling down the trunk of the tree upon which they were hatched and across a considerable stretch of ground, to ascend another tree. When they occur in numbers, an extensive migration will always take place from a tree which has been nearly defoliated, and the species spreads mainly, if not entirely, in this way. Just as is the case with the gypsy moth,

the caterpillars are carried by vehicles upon which they crawl or drop, or upon the clothes of passers-by, and in this way many trees upon which there were no egg masses become infested.

The larval state lasts, on an average, from a month to five weeks. When full grown, the larvæ spin delicate grayish cocoons of silk mixed plentifully with hairs. The mixture of hair is brought about by the fact that the hairs are barbed and rather loosely attached to the body. When a caterpillar begins to spin its cocoon the hairs of its body and those of the long, black tufts on the prothorax first become entangled with the silken threads and are pulled out. By the time the cocoon has

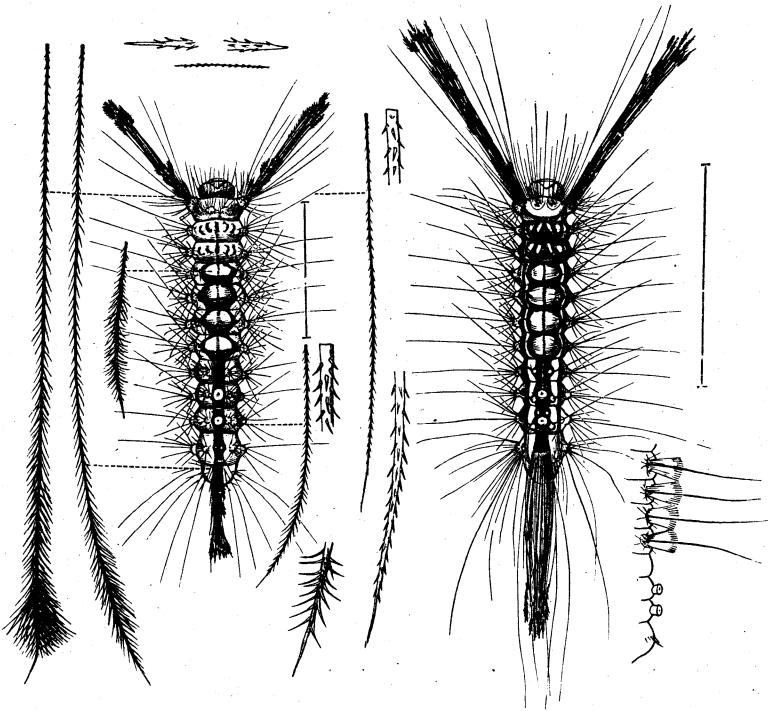


FIG. 6.—Tussock-moth caterpillar. Third and fourth stages, showing enlarged hairs from different parts of body (original).

begun to take shape, the characteristic long, black tufts of hair have entirely disappeared from the body of the caterpillar. Later the shorter hairs of the sides of the body become entangled and removed, and finally many of the hairs composing the brush-like tufts upon the fore part of the body are pulled out, and just before it transforms to pupa the caterpillar bears but a remote resemblance to the individual before it began to spin.

The barbed hairs just mentioned may occasionally produce considerable irritation of the skin of people upon whom the caterpillars may have crawled or dropped from the trees. The hairs from the different

portions of the body of the full-grown caterpillar are illustrated, greatly enlarged, in fig. 6, and it is the shorter hairs from the sides which probably cause the irritation. They are very small, fall out readily, and, when a caterpillar crawls over the skin of an individual who is warm and perspiring, these very sharply barbed hairs produce an irritation which in some individuals has been the cause of much discomfort, creating more or less inflammation and swelling.

The larva transforms to pupa within a few hours after the completion of the cocoon, and remains in the pupal condition from ten days to two weeks. The cocoons of this first generation, while mainly spun on the trunk and larger branches, are also spun to a very considerable extent upon the smaller branches and twigs, and even on the partly eaten leaves.

The adult insect presents the rather unusual phenomenon of a winged, active male and a degraded, absolutely wingless female. It is this fact which makes the spread of the species dependent upon the traveling powers of the caterpillar, as mentioned in the preceding paragraph. The male and female pupæ and the male and female moths are so well shown in fig. 4 as to need no description.

Coupling takes place upon issuing from the cocoon, and immediately afterwards the females begin to lay their eggs, clinging firmly to the cocoons from which they have issued and attaching the egg mass to the lower half of the cocoon, in the manner shown in fig. 4, *h* and *k*. As soon as the eggs are laid the females die, and usually fall to the ground, although sometimes their shriveled bodies remain clinging by the legs to the upper part of the cocoon.

We have made no observations as to the duration of these midsummer eggs. Unfortunately, upon the length of time which elapses before hatching depends exact information as to the number of annual generations. Specific observations in 1895 in Washington were not begun until August 15. At that time the egg masses were everywhere to be seen, and about that time the eggs began to hatch. From the early statements of Riley it was assumed that these were the eggs of the second generation, but reference to the notebooks of the office shows that on several occasions overwintered eggs have hatched in Washington in April, and adults have issued as early as the middle of June. From the middle of June to the middle of August is certainly long enough to allow for a generation of this insect. Assuming that such a generation had developed, larvæ from these August eggs would belong to the third generation.¹ This, however, is to a certain extent guess-work, and the regrettable lapse of observations during the last half of

¹ Observations made during 1896 confirmed fully the surmise here recorded that the white-marked tussock moth has at Washington three generations annually, instead of two, as previously stated by Riley. (See Bulletin 10, Division of Entomology, p. 33.)

June, the whole of July, and the first half of August could be remedied only in another season.

Elaborate observations were made upon this August brood in 1895, the individuals of which were present in extraordinary numbers. Certain of the larvæ under observation, which hatched on August 2, commenced to spin upon September 3, and on September 14 the first male moths made their appearance, the first females issuing September 19. During the latter part of September the bulk of the moths issued, and the conspicuous white egg masses were very abundant by the 1st of October. Many of these egg masses were kept under observation from that time on. In the cold room of the insectary (temperature the same as outdoors) a few eggs hatched about the close of the second week in October, and on October 23 two newly hatched larvæ were observed upon an egg mass collected out of doors. This late fall hatching, however, is probably exceptional, but in a late, warm autumn it is likely to be rather general. It is hardly to be supposed that any individuals hatching after the 1st of October will successfully transform. The cocoons of this late fall generation are almost invariably spun upon the trunk of the tree and in the crotches of the main limbs, but occasionally, in the case of large trees, upon the larger limbs themselves. The tendency of all the larvæ of this generation is to crawl toward the ground before transforming. Cocoons are occasionally spun upon fences or other objects near the trees upon which the larvæ have been reared, but the vast majority are found upon the trunks.

There are, then, certainly two, and probably three, annual generations at Washington.¹ In New York and Brooklyn there are two well-marked generations. At Boston, as is learned from Mr. Samuel Henshaw, there are two generations. Farther north, however, although the statement is based upon no exact observation, it is not at all likely that there are more than one, and, as stated in the introduction, the comparative harmlessness of the species in such regions is probably due to the nondevelopment of the second generation.

Remedies.—There are two classes of remedies as well as an excellent preventive that may be used to advantage against this insect. These are the collection or destruction of the eggs in the winter, spraying the trees against the larvæ, and banding unattacked trees to prevent the ascent of the caterpillars and the subsequent development of moths and the laying of eggs.

The collection and destruction, or the destruction without collecting, of the eggs must be thorough in order to have any practical efficacy. The great majority of the hibernating egg masses are deposited low down on the trunk of the tree or upon the main limbs, so that they can

¹ Certainly occasionally, and probably always, three, as indicated in the footnote on the preceding page.

be reached in one way or another without much difficulty. The egg mass is compact, and, being attached to the somewhat flimsy cocoon and not to the bark, it is easily removed either by hand or by scraping it off. The egg masses which have been scraped off must not be allowed to remain at the surface of the ground, but should be collected and burned. A scraper for the removal of egg masses which occur too high to be reached by hand has been devised by Mr. Southwick, of Central Park, New York City, and consists of a very small hoe blade at the end of a long pole. Perfectly unskilled labor can be utilized in this operation, but the workman should be impressed with the necessity of absolute thoroughness; not an egg mass should be overlooked.



FIG. 7.—Silver maple leaves eaten by larvæ of white-marked tussock moth in successive stages of growth from *a* (newly hatched larvæ) to *f* (full-grown larvæ)—reduced (original).

In the work against the gypsy moth in Massachusetts it has been found that the egg masses can not be removed to the best advantage by means of scrapers. The eggs are attached, not to the cocoons, but to the bark of the trees, and certain eggs may be left in the attempt to remove the mass. An extensive series of experiments has therefore been carried on with a view to securing a liquid which will penetrate and destroy the egg masses.

A satisfactory liquid for this purpose has been found in creosote oil, to which turpentine is added to keep it liquid in cold weather, with tar to blacken it so that treated egg masses can be recognized at a glance.

The workman is furnished with a pole, to the end of which a small sponge is tied. He goes from tree to tree, dipping the sponge occasionally into the creosote preparation and touching with it each egg mass found. This is a simple and very rapid method. It has the advantage of rapidity over the scraping method described above, since after the eggs are scraped off they must be collected and carried away for burning.

A modification of this plan may be used to advantage against the tussock moth. The pure white color of the egg mass of the tussock moth, however, renders the use of coal tar in the preparation unnecessary, since the creosote oil alone will discolor it enough to render a treated mass recognizable at a distance.

No explicit directions for spraying with arsenical poisons against this insect are needed. The same liquid and the same apparatus that

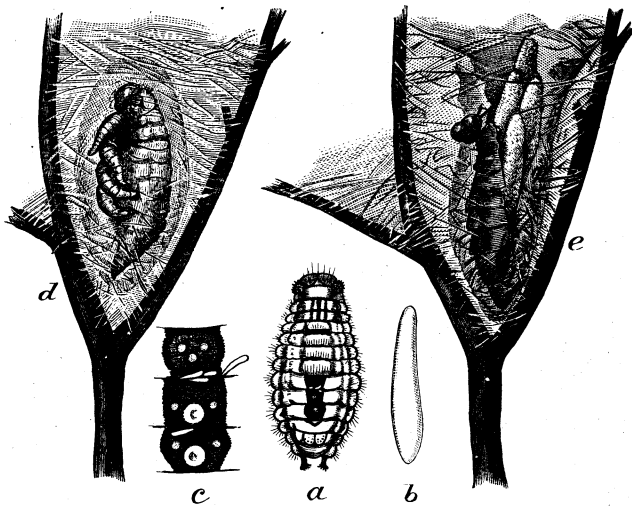


FIG. 8.—*Pimpla inquisitor*, an Ichneumonid parasite of tussock-moth caterpillar. *a*, parasitized caterpillar; *b*, egg of parasite; *c*, same *in situ*; *d*, parasite larvæ issuing; *e*, parasite cocoons—all slightly enlarged, except *b* and *c*, which are much enlarged (original).¹

are used against the elm leaf-beetle may be used against this insect, and the spraying may be done at about the same time of the year. It is essential that the caterpillars of the first generation shall be killed, as the second and more destructive brood will thus be prevented.

Banding of the trees is practiced to advantage with this species. It is the only one of the shade-tree insects, except the bagworm, which has a wingless female. All the others, except the gypsy moth, spread

¹See Bulletin 5, technical series, Division of Entomology, and Bulletin 9, new series, pages 15-17, for an extended account of the parasites of this species. The injurious outbreak of 1895 was checked in the most perfect manner by these parasites, so that the tussock moth was hardly to be noticed during the latter part of 1896, or during 1897 or 1898.

from tree to tree by the flight of the female. Many experiments have been made with different styles of bands, and it has been practically proved that a broad, thick strip of raw cotton, tied about the trunk of the tree with a string, is after all the most efficacious and perhaps the cheapest. Such bands have to be renewed occasionally, as they become more or less matted together and spoiled by rainstorms.

Next in point of efficacy will probably come bands of insect lime, several brands of which are on the market. Insect lime is a sticky, coal-tar product, which retains its viscidty for a considerable time. A ring made around a tree will remain operative for some weeks in warm weather.

THE FALL WEBWORM.

(*Hyphantria cunea* Drury; figs. 9 to 11.)

Associated with the white-marked tussock moth in its damage to the shade trees of the city of Washington during the summer of 1895, were very many specimens of the fall webworm; in fact, this insect was more abundant during the summer of 1895 than it has been in Washington since 1886. It was not as numerous and destructive as the white-marked tussock moth, and the last generation was so extensively parasitized as to lead to the anticipation that the species would not be especially abundant during 1896.

The fall webworm is a typical American species. It is found from Canada to Georgia and from Montana to Texas. It is an almost universal feeder, and the records of the Division of Entomology list about 120 species of shade and ornamental trees, as well as fruit trees, upon the leaves of which it feeds.

In the District of Columbia and north to New York City there are two generations annually, as is the case with the tussock moth. In more northern localities, where it is single-brooded, it loses its place as a species of great importance. It hibernates as a pupa within a cocoon attached to the trunk of its food plant, or to tree boxes, neighboring fences, or to rubbish and sticks or stones at the surface of the ground. The different stages of the insect are shown in figs. 9 to 11. The moth, which may be either pure white or white spotted with black, flies at night and deposits a cluster of 400 or 500 eggs, upon either the upper or the under surface of the leaf. The caterpillars feed gregariously, and each colony spins a web which may eventually include all the leaves of a good-sized limb. Reaching full growth, the caterpillars leave the web and crawl down the trunk of the tree to spin their cocoons. The caterpillars of the second generation begin to make their appearance in force in August.

Remedies.—On account of the fact that the adult female is an active flier, we can use against the fall webworm but two of the remedies suggested for use against the tussock-moth caterpillars, namely, spraying with arsenical poisons and the collection of the cocoons. The gre-

gious habit of the larvæ, however, suggests another remedy which is practical and very efficient if thoroughly carried out. This is the destruction of the webs and the contained larvæ, either by cutting off the twigs which carry them and burning immediately, or burning the webs without pruning. If this work be done properly and against the early summer generation, the pruning method is unnecessary and inadvisable. By the use of a proper torch the webs and the caterpillars which they contain can be burned off at nightfall without necessarily destroying the life of the twigs, and a second crop of leaves will be put out a little later, so that the tree does not remain disfigured for any length of time. A bundle of rags wired to the end of a pole and saturated with kerosene makes a good torch for the purpose; or a porous brick wired to a pole and saturated with kerosene answers the purpose even better. Private persons will find this remedy sufficient. City authorities should apply an arsenical spray. Collecting the cocoons in winter may be carried on simultaneously with the collection of the egg masses of the white-marked tussock moth, but this, as well as other community remedies, will be referred to at another place.

THE RELATIVE IMMUNITY FROM INSECTS OF DIFFERENT VARIETIES OF SHADE TREES.

As regards a number of the principal shade trees that are most commonly grown, there does not seem to be any great preference on the part of the fall webworm and the tussock-moth caterpillar. If a moth happens to lay her eggs upon or near a given tree standing in a row, the species will naturally spread along the row before it will cross to the opposite side. In this way erroneous ideas of the relative immunity of trees have frequently been gathered.

Taking the insect question as a whole, however, there is a decided difference in the relative value of certain varieties. In December, 1893, the Tree Planting and Fountain Society of Brooklyn asked a number of experts to name for the use of the society nine of the most valuable trees for planting in Brooklyn. Three of these trees were to be large-growing, three medium-sized, and three small-growing varieties.

The reply of Mr. B. E. Fernow, Chief of the Division of Forestry in the United States Department of Agriculture, was comprehensive and of great value. He tabulated nearly 50 varieties, analyzing their good qualities under the different heads of endurance, recuperative power, cleanliness, beauty of form, shade, leaf period, rapidity of growth, and persistence, giving 3 as the highest mark for any one of these qualities and estimating the value of a given tree by the total number of marks given to it. This reply was printed and issued as a circular by the Brooklyn society. Mr. Fernow made no specific rating for immunity from insect pests, although in his introductory remarks he seems to have included the insect question under the head of cleanliness.

As is quite to be expected, the rating arrived at from the summing up of the qualities mentioned differs very considerably from the rating which might be arrived at from the quality of immunity from insects. Taking the large and medium-sized trees only (36 species in all), Mr. Fernow's rating stands as follows, only the total gained by the addition of the ratings in the several qualities considered being given:

Variety of tree.	Total rating (Fernow).	Insect rating (Howard).
LARGE-SIZED TREES.		
Red oak (<i>Quercus rubra</i>)	22	2.5
Scarlet oak (<i>Quercus coccinea</i>)	22	2.5
Yellow oak (<i>Quercus velutina</i>)	22	2.5
American elm (<i>Ulmus americana</i>)	22	1.5
Sugar maple (<i>Acer saccharum</i>)	19	2.5
Black maple (<i>Acer nigrum</i>)	19	2.5
Tulip tree (<i>Liriodendron tulipifera</i>)	19	3.0
European linden (<i>Tilia vulgaris</i>)	19	1.5
Small-leaved linden (<i>Tilia microphylla</i>)	19	2.0
Sweet gum (<i>Liquidambar styraciflua</i>)	19	2.0
White oak (<i>Quercus alba</i>)	19	2.0
Bur oak (<i>Quercus macrocarpa</i>)	19	2.0
Oriental plane tree (<i>Platanus orientalis</i>)	19	1.5
Kentucky coffee tree (<i>Gymnocladus dioica</i>)	19	2.0
American plane tree (<i>Platanus occidentalis</i>)	18	1.5
Sycamore maple (<i>Acer pseudo-platanus</i>)	17	2.0
American linden (<i>Tilia americana</i>)	17	1.5
MEDIUM-SIZED TREES.		
Red maple (<i>Acer rubrum</i>)	22	2.0
Shingle oak (<i>Quercus imbricaria</i>)	21	2.0
Willow oak (<i>Quercus phellos</i>)	21	2.5
Slippery elm (<i>Ulmus pubescens</i>)	21	2.0
Norway maple (<i>Acer platanoides</i>)	20	2.0
Box elder (<i>Negundo negundo</i>)	20	.0
European elm (<i>Ulmus campestris</i>)	19	.5
Scotch elm (<i>Ulmus montana</i>)	19	1.0
Hackberry (<i>Celtis occidentalis</i>)	19	1.5
Silver-leaved maple (<i>Acer saccharinum</i>)	17	1.5
Tree of heaven (<i>Ailanthus glandulosa</i>)	16	2.5
Horse chestnut (<i>Æsculus hippocastanum</i>)	16	2.0
Japanese sophora (<i>Sophora japonica</i>)	16	2.5
Hardy catalpa (<i>Catalpa speciosa</i>)	16	2.0
Ginkgo (<i>Ginkgo biloba</i>)	16	3.0
Honey locust (<i>Gleditsia triacanthos</i>)	15	1.0
Cottonwood (<i>Populus monilifera</i>)	15	.5
Balm of Gilead (<i>Populus balsamifera</i> v. <i>candicans</i>)	15	.5
Black locust (<i>Robinia pseudacacia</i>)	14	.5

The writer has made ratings of these same trees according to their immunity from the attacks of insects, the trees most immune being rated at 3 and those most attacked by insects at 0. The figures relating to insect attack are displayed above in a contrasted column next to the total rating, and in order that the relative importance from the

insect standpoint may be seen at a glance the same trees have been rearranged in a separate table as follows:

Variety of tree.	Insect rating.	Variety of tree.	Insect rating.
Gingko (<i>Ginkgo biloba</i>)	3.0	Shingle oak (<i>Quercus imbricaria</i>)	2.0
Tulip tree (<i>Liriodendron tulipifera</i>)	3.0	Slippery elm (<i>Ulmus pubescens</i>)	2.0
Sugar maple (<i>Acer Saccharum</i>)	2.5	Norway maple (<i>Acer platanoides</i>)	2.0
¹ Red oak (<i>Quercus rubra</i>)	2.5	Hardy catalpa (<i>Catalpa speciosa</i>)	2.0
Tree of heaven (<i>Ailanthus glandulosa</i>)	2.5	European linden (<i>Tilia vulgaris</i>)	1.5
¹ Scarlet oak (<i>Quercus coccinea</i>)	2.5	American elm (<i>Ulmus americana</i>)	1.5
Yellow oak (<i>Quercus velutina</i>)	2.5	Hackberry (<i>Celtis occidentalis</i>)	1.5
Willow oak (<i>Quercus phellos</i>)	2.5	Silver-leaved maple (<i>Acer saccharinum</i>)	1.5
Black maple (<i>Acer nigrum</i>)	2.5	Oriental plane tree (<i>Platanus orientalis</i>)	1.5
Japanese sophora (<i>Sophora japonica</i>)	2.5	American plane tree (<i>Platanus occidentalis</i>)	1.5
Horse-chestnut (<i>Æsculus hippocastanum</i>)	2.0	American linden (<i>Tilia americana</i>)	1.5
Red maple (<i>Acer rubrum</i>)	2.0	Honey locust (<i>Gleditsia triacanthos</i>)	1.0
Small-leaved linden (<i>Tilia microphylla</i>)	2.0	Scotch elm (<i>Ulmus montana</i>)	1.0
White oak (<i>Quercus alba</i>)	2.0	Cottonwood (<i>Populus monilifera</i>)5
Sweet gum (<i>Liquidambar styraciflua</i>)	2.0	Balm of Gilead (<i>Populus balsamifera</i> v. <i>candicans</i>)5
Bur oak (<i>Quercus macrocarpa</i>)	2.0	European elm (<i>Ulmus campestris</i>)5
Kentucky coffee tree (<i>Gymnocladus divinis</i>)	2.0	Black locust (<i>Robinia pseudacacia</i>)5
Sycamore maple (<i>Acer pseudo-platanus</i>)	2.0	Box elder (<i>Negundo negundo</i>)0

¹ This estimate of the red oak and scarlet oak was based largely on the beautiful condition of certain trees growing in the streets of Washington, D. C. Since the publication of the Yearbook article, however, several of these trees have developed rather serious cases of insect injury. The locust borer (*Xyleutes robinia*) has attacked a number of the trees, and although it is not apparently weakening their vitality to any serious extent, still it bids fair to do considerable damage. The trees have been treated by injecting a small quantity of bisulphide of carbon into the burrows and covering the opening with putty. In a few cases the obscure scale (*Aspidiotus obscurus*) has attacked these trees. It has not as yet killed any branches, but it multiplies as abundantly as its dangerous relative, *A. tenebricosus*, of the maple, and I see no reason why it should not be an equally injurious species. This experience somewhat shakes the confidence of the writer in his estimate of the rating of these oaks, but not to any very serious extent.

It will be noticed that the trees listed by Mr. Fernow which we find to be most immune are the gingko and the tulip tree. Outside of the grounds of the Department of Agriculture at Washington and Central Park, New York, few gingko trees are grown in this country, except as occasional isolated examples. The tree itself is a very beautiful one, and singularly free from insect attack. In the long double row of these trees, now nearly twenty-five years old, on the grounds of the Department of Agriculture, but one species of injurious insect has ever been found, and the work of this species is very insignificant. It is the little sulphur-yellow leaf-roller, *Tortrix sulphureana*.

The tulip tree, which is given the same rating, is, for practical purposes, almost as exempt as the gingko. Of late years in the District

of Columbia it has been rather extensively infested by a plant louse (*Siphonophora liriodendri*), but although the lice occur on the leaves in great numbers, the general appearance of the trees has not suffered. There is a little gall midge which produces little black spots on the tulip tree leaves and disfigures them to some extent, and quite recently Mr. Schwarz has found that tulip scrub is affected to some extent in the District of Columbia by a little bark-boring beetle.

The box elder is a singularly unfortunate choice for a shade tree in this climate. It is almost defoliated by the webworm, it is sought after by the tussock moth, and various leaf-rollers attack it as well as

certain destructive borers. In the West the box-elder plant-bug (*Leptocoris trivittatus*) breeds upon it in enormous numbers, and not only damages the trees to a serious extent, but causes much further annoyance by entering houses for hibernation.

The European elm is given a low rank, almost entirely on account of its annual defoliation by the imported elm leaf-beetle.

The honey locust and the black locust, while not defoliated to the same extent as many other trees by the webworm and the tussock-moth caterpillar, are rendered very unsightly almost every year by the work of a leaf-mining Hispid beetle and of certain Lepidopterous leaf miners. They are also fre-



FIG. 9.—Fall webworm (*Hyphantria cunea*). Moths and cocoons—natural size (original).

quently killed by the large Lepidopterous borer, *Xyleutes robiniae*, and certain Coleopterous borers also infest them.

From the insect standpoint, there are several fine-growing ornamental trees on the grounds of the Department of Agriculture, not listed above, which are seldom attacked by insects. The beeches, hornbeams, alders, and magnolias have very few insect enemies, and are rarely defoliated by either of the principal leaf-eating caterpillars.

With regard to the extreme attractiveness which the European elm possesses for the imported elm leaf beetle, the question is frequently asked whether it would not be better to cut down all European elms

growing in parks or in rows with American elms. Such a course, however, would seem to be undesirable. After the elm leaf-beetle has established itself in a given locality, it will attack the American elms to a very serious extent, in the absence of its favorite food plant. It is, therefore, better to allow a few European elms to remain. These will then act as trap trees, and the necessity for treating a large number of trees will in most cases be greatly reduced.

In selecting shade trees, particularly for small cities and towns in agricultural regions, and even to a considerable extent in large cities, the relative honey-producing qualities of the proposed shade trees is a matter of some little importance; not so much, perhaps, in the matter of actual food for the ordinary honeybee as in that of the increase of bees on account of their great value as cross fertilizers of orchard trees and forage crops. From this point of view, there are five very important honey producers among the principal shade trees. These are, in order of importance: American linden, tulip tree, black locust, horse-chestnut, and sugar maple.

GENERAL WORK AGAINST SHADE-TREE INSECTS IN CITIES AND TOWNS.

The question of proper work against the insects which affect shade trees in cities and towns naturally divides itself under two heads: (1) What can be efficiently and economically done by city governments? (2) If city or town administrators will not appropriate a small amount of money to carry on work of this kind, what can citizens who are interested in the preservation of shade trees do?

The planting of shade trees seems to be considered a legitimate function of the board of public works in every municipality. It is sometimes done by a specially appointed officer, under the control of the superintendent of streets and sewers; or it is placed in charge of a subcommittee of the board, or a special commission of outsiders is appointed to superintend the work. Admitting that the planting of shade trees is a public matter, their care should also be a public duty. Yet in not one of the larger or smaller cities of the Eastern United States with which the writer is familiar is any proper amount of work done by the public authorities against shade-tree insects. New York is the only city in the country where a man of entomological knowledge is employed to direct operations against shade-tree insects, either in the streets or the public parks. The writer does not wish to be understood as advocating the appointment of a paid entomologist by every city government, although where the parks are large in cities situated within the region of greatest shade-tree insect activity, such a course is always desirable. With an intelligent and industrious superintendent of parks, or a city forester, or whatever he may be termed, and the wise expenditure of a comparatively small amount of money each year,

the shade trees of any city could be kept green throughout the summer.

The amount of money to be expended in this direction would naturally vary with the number of trees to be attended to, as well as with the variety and the size of the trees and the geographical location of the city. Even in Brooklyn, however (and this seems to the casual observer to be the most unfortunate of all our Eastern cities from this standpoint), it is within bounds to estimate that the expenditure of \$4,000 to \$5,000 a year would result in green shade trees the summer

through. This amount, moreover, will in all probability not need to be an annual appropriation. The first cost of a proper spraying apparatus will have to be added, but the apparatus once purchased and thorough work performed for two or three years consecutively, the probabilities are strong that the number of shade-tree insects would be reduced to such an extent that a considerably smaller annual expenditure would be sufficient.

The question of proper spraying apparatus is a rather serious one, since in this direction a considerable amount of money should be expended. A steam apparatus will do the work with much greater rapidity than a hand pump; and yet with a strong,

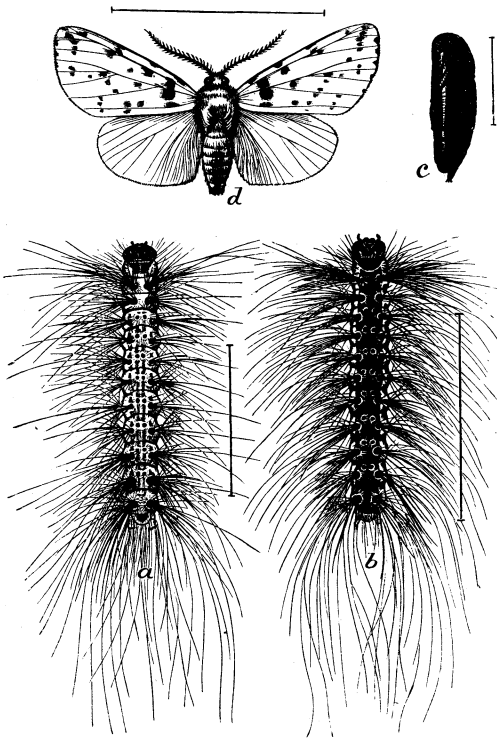


FIG. 10.—Fall webworm. *a*, light form of full-grown larva; *b*, dark form of same; *c*, pupa; *d*, spotted form of moth (compare fig. 9)—all slightly enlarged (original).

double-acting force pump, which can be operated by a single man, and a tank of 100 gallons capacity, mounted upon a strong cart, many large trees can be well sprayed in the course of a day. From such a pump two lines of hose may be run with advantage.¹ The working force of such an apparatus should be a horse to draw the cart, a man to drive and do the pumping, and one man to each line of hose. Several such machines

¹ In the Yearbook of this Department for 1896 will be found an article by the writer entitled "The use of steam spraying apparatus," to which persons interested in such matters are referred in this connection.

have been used with good results in the work of the Gypsy Moth Commission, both for street trees and in the public parks. A steam apparatus, however, of such a capacity that a pressure of 75 pounds per square inch may be gained will enable the operation of four or five lines of hose simultaneously. The rapidity of work will therefore be doubled, and certainly by the use of two such pumps the shade trees of any ordinary city can be gone over with sufficient rapidity to destroy all insects within the required time. A boiler mounted on a truck, the boiler to be complete with all fixtures, smokestack, bonnet, firing tools, springs to the truck, and a pump having a capacity of 10 to 20 gallons a minute connected with the boiler ready for operation, can be purchased for a sum well within \$500. This truck should be mounted on wheels with broad tires, for running over sandy roads. Connecting

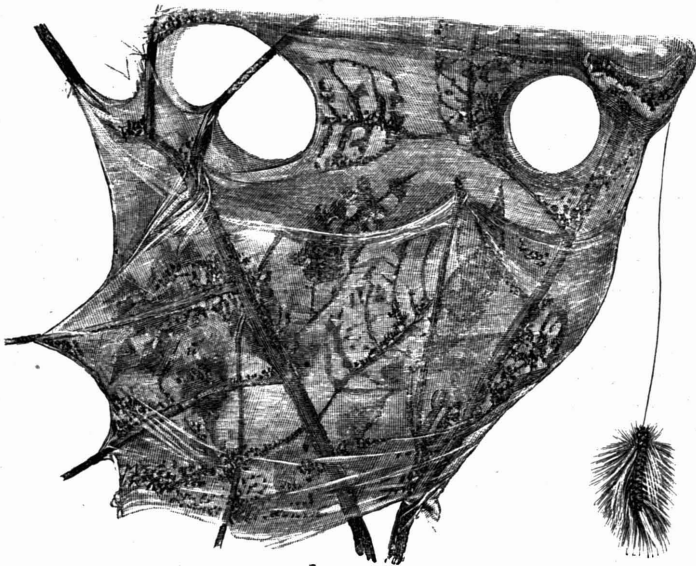


FIG. 11.—Fall webworm. Suspended larva and section of web—natural size (original).

this apparatus with a proper tank cart would be an additional expense, not to exceed \$100 for a tank of a capacity of 200 gallons. Such an apparatus, furnished with hose and smoothbore nozzles of about one-sixteenth inch in diameter, when discharging under 40 pounds pressure from each of several such nozzles, would spray about half a gallon of insecticide mixture per nozzle per minute.

A strong steam pump, to be used in connection with a small oil-burning boiler, the whole apparatus on a smaller scale than that described above, has been estimated at \$275 by a prominent New York firm, delivered on board the cars.

There is no reason why an old steam fire engine could not be readily arranged for this shade-tree spraying work. In one or two instances a steam fire engine has been used for this purpose without

modification, the object being simply to knock the insects from the trees by means of a strong stream of water. By such means as this the Superintendent of the Military Academy kept the elm trees green at West Point several years ago. In every large city, where the fire department is necessarily kept in the best condition, an engine is occasionally retired. The transfer of such a retired engine to the street department could no doubt be readily made, and a little work by a competent steam fitter could transform it into a most admirable insecticide machine. In this way the initial expenditure for machinery would be avoided.

When the spraying apparatus has once been provided, the funds necessary for the purchase of insecticides and the necessary labor at the proper time must be available. If the work is not done promptly and at just the right time, more or less damage will result, and a greater expenditure will be necessary. During the latter part of May and the first part of June, in the case of nearly all prominent shade-tree insects, one or two thorough sprayings must be made. In fact, a second spraying, begun immediately after the completion of the first one, will in ordinary cases be as much as need be expected. In addition to this spraying work, a force of men must be employed for a time in July to destroy the elm leaf-beetle larvæ as they are descending to the ground and to burn the webs of the first generation of the fall webworm. This will finish the summer work. The winter work will consist of the destruction of the eggs of the white-marked tussock moth, the cocoons of the fall webworm, and the bags of the bagworm. The number of men to be employed and the time occupied will depend upon the exigencies of the case. Upon the thoroughness of this work will depend, to a large extent, the necessity for a greater or less amount of the summer work just described.

We have now to consider what can be done by citizens where city governments will not interest themselves in the matter. It is unreasonable to expect that a private individual will invest in a spraying apparatus and spray the large shade trees in front of his grounds. Therefore, in spraying operations where large trees exist in numbers there must be combination of resources. This affords an opportunity for the newly invented business of spraying at so much per tree. A resident of Bridgeport, Conn., who was formerly, and is yet for the greater part of the year, a roofer and paver, has constructed several cart sprayers, and during the months of June and July (at a time, by the way, when the men in his employ are apt to be out of work) he sprays trees on the grounds of private individuals and along the streets in front of their grounds, under contract, at so much per tree, guaranteeing to keep the trees in fair condition during the season. His work has been directed solely against the elm leaf-beetle, since that is the only insect of great importance in Bridgeport. In the month of July, 1894, the writer, in driving through the streets of

Bridgeport, found it easy to pick out the trees which had been treated in this way. Such elms were green, while all others were brown and nearly leafless. The defect of this plan as a general practice lies in the fact that not all property owners or residents can afford to employ a tree sprayer, while others are unwilling, since they deem it the business of the city authorities, or do not appreciate the value of tree shade.

Any effort, therefore, looking toward the arousing of popular sentiment or the banding together of the citizens in the interests of good shade is desirable. A most excellent plan was urged by one of the Washington newspapers in the summer of 1894. It advocated a tree-protection league, and each issue of the paper through the summer months contained a coupon which recited briefly the desirability of protecting shade trees against the ravages of insects, and enrolled the signer as a member of the league, pledging him to do his best to destroy the injurious insects upon the city shade trees immediately adjoining his residence. This is only one of several ways which might be devised to arouse general interest. The average city householder seldom has more than a half dozen street shade trees in front of his grounds, and it would be a matter of comparatively little expense and trouble for any family to keep these trees in fair condition. It needs only a little intelligent work at the proper time. It means the burning of the webs of the fall webworm in May and June; it means the destruction of the larvæ of the elm leaf-beetle about the bases of elm trees in late June and July; it means the picking off and destruction of the eggs of the tussock moth and the bags of the bagworm in winter, and equally simple operations for other insects should they become especially injurious. What a man will do for the shade and ornamental trees in his own garden he should be willing to do for the shade trees 10 feet in front of his fence.

FARMERS' BULLETINS.

These bulletins are sent free of charge to any address upon application to the Secretary of Agriculture, Washington, D. C. Only the following are available for distribution:

- No. 16. Leguminous Plants for Green Manuring and for Feeding. Pp. 24.
- No. 18. Forage Plants for the South. Pp. 30.
- No. 19. Important Insecticides: Directions for Their Preparation and Use. Pp. 20.
- No. 21. Barnyard Manure. Pp. 32.
- No. 22. Feeding Farm Animals. Pp. 32.
- No. 23. Foods: Nutritive Value and Cost. Pp. 32.
- No. 24. Hog Cholera and Swine Plague. Pp. 16.
- No. 25. Peanuts: Culture and Uses. Pp. 24.
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- No. 95. Good Roads for Farmers. Pp. 47.
- No. 96. Raising Sheep for Mutton. Pp. 48.
- No. 97. Experiment Station Work—X. Pp. 32.
- No. 98. Suggestions to Southern Farmers. Pp. 48.